CLEAN VERSION

IN THE CLAIMS

Please insert the following numbers for the claims originally filed.

1. A thermally activated, chemically based marking method comprising steps of:

   electrostatically applying a layer of an energy absorbing marking material to a conductive or dielectric substrate to be marked; and

   irradiating said layer with a radiant energy beam having a wavelength selected to excite said energy absorbing material in accordance with the form of a marking to be applied, thereby forming a marking layer atop said substrate.

2. The method of claim 1, further comprising a step of providing a laminar air flow across said substrate during the irradiating step.

3. The method of claim 1, wherein said marking material comprises at least one metal compound.

4. The method of claim 3, wherein said metal compound is an oxide.

5. The method of claim 4, wherein said compound is a mixed metal oxide.

6. The method of claim 3, wherein said compound is a sulfide.

7. The method of claim 3, wherein said compound is a sulfate.

8. The method of claim 3, wherein said compound is a carbonate.

9. The method of claim 1, wherein said marking material comprises Kaolin clay.

10. The method of claim l, wherein said marking material comprises an energy absorbing enhancer.

11. The method of claim 1, wherein said marking material comprises at least one colorant.

12. The method of claim 10 wherein said energy absorbing enhancer comprises carbon black.

13. The method of claim 1, wherein said substrate comprises materials selected from the group consisting of metals, glasses, ceramics and plastics.

14. The method of claim 13, wherein said substrate comprises at least one metal.

15. The method of claim 13, wherein said substrate comprises at least one glass.

16. The method of claim 1, wherein said marking material comprises at least one glass frit material.

17. The method of claim 16, wherein said glass frit material comprises at least one oxide selected from oxides of alkali metals, alkaline earth metals, silicon, boron and transition metals,

18. The method of claim 1, wherein said marking material comprises at least one glass frit material and at least one metal compound.

19. The method of claim 11, wherein said marking material comprises at least one organic pigment.

20. The method of claim 1, wherein said marking material is applied by direct electrostatic coating of a conductive substrate.

21. The method of claim 1, wherein said marking material is applied by direct electrostatic coating of a dielectric substrate, after said substrate has been coated with a layer of conductive material.

22. The method of claim 1, wherein said marking material is applied as dry particles.

23. The method of claim 1, wherein said marking material is applied as liquid droplets.

24. The method of claim 1, wherein said marking material is electrostatically applied in the form of a marking to be applied to said substrate.

25. The method of claim 1 wherein said radiant energy beam is produced by a laser, diode laser or diode-pumped laser.

26. A substrate as marked by the method of claim 1.

27. A thermally activated, chemically based marking method comprising steps of:

electrostatically applying a layer of mixed metal oxide material containing an energy absorbing enhancer to a metal substrate; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the metal oxide material and/or said energy absorbing enhancer in accordance with the form of a marking to be applied, thereby forming a marking layer atop the substrate.

28. The method of claim 27 further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

29. The method of claim 27, wherein the mixed metal oxide material comprises at least one colorant, and the energy absorbing enhancer comprises carbon black.

30. The method of claim 27, wherein the radiant energy beam comprises a laser beam having an energy level ranging between 1 and 30 watts, a spot size ranging between 5 and 200 microns, and a marking speed along the substrate ranging between 25 and 1000mm/sec.

31. The method of claim 27, wherein the layer of mixed metal oxide material has a thickness ranging between 5 and 500 microns.

32. The method of claim 27 wherein said irradiating step is started at a room temperature of about 70° F.

33. A metal substrate as marked by the process according to claim 27.

34. A thermally activated chemically based marking method comprising steps of:

electrostatically applying a layer of mixed metal oxide material containing an energy absorbing enhancer to a substrate selected from the group consisting of aluminum, brass, chrome, copper, nickel, steel, stainless steel, tin, glass, ceramics, porcelain, and plastics; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer in accordance with the form of a marking to be applied, thereby forming a marking layer atop the substrate.

35. The method of claim 34 further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

36. The method of claim 34, wherein said mixed oxide material is applied as dry particles.

37. The method of claim 34, wherein said mixed oxide material is applied as liquid droplets.

38. The method of claim 34, wherein the energy absorbing enhancer comprises carbon black.

39. The method of claim 34, wherein the radiant energy beam comprises a laser beam having an energy level ranging between 1 and 30 watts, a spot size ranging between 5 and 200 microns, and a marking speed along the substrate ranging between 25 and 1000mm/sec.

40. The method of claim 34, wherein the layer of mixed metal oxide material has a thickness ranging between 5 and 500 microns.

41. The method of claim 34 wherein said irradiating step is started at a room temperature of about 70° F.

42. The method of claim 34, wherein the mixed metal oxide material comprises a colorant.

43. A substrate material as laser marked by the process according to claim 34.

44. A thermally activated, chemically based marking method comprising steps of:

electrostatically applying a layer of mixed metal oxide material containing an energy absorbing enhancer to a substrate to be marked in the form of a marking to be applied; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer, thereby forming a marking layer atop the substrate.

45. The method of claim 44, further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

46. The method of claim 44, wherein said mixed metal oxide material is applied as dry particles.

47. The method of claim 44, wherein said mixed metal oxide material is applied as liquid droplets.

48. The method of claim 44, wherein the energy absorbing enhancer comprises carbon black.

49. The method of claim 44, wherein the radiant energy beam comprises a laser beam having an energy level ranging between 1 and 30 watts and a marking speed along the substrate ranging between 25 and 1000mm/sec.

50. The method of claim 44, wherein the layer of metal oxide material has a thickness ranging between 5 and 500 microns.

51. The method of claim 44, wherein the irradiating step is started at a room temperature of about 70° F.

52. The method of claim 44, wherein the mixed metal oxide material comprises a colorant.

53. A substrate material as marked by the process according to claim 44.

54. A thermally activated chemically based marking method comprising steps of:

electrostatically applying a layer having a metal oxide component and comprising an energy absorbing enhancing component to a metal substrate; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancing component, thereby forming an adhered marking layer atop the substrate.

55. A thermally activated, chemically based marking method comprising steps of:

electrostatically applying a layer having a mixed metal oxide component and an energy absorbing enhancing component to a substrate selected from the group consisting of aluminum, brass, chrome, copper, nickel, steel, tin, glass, ceramics, and plastics; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancing component, thereby forming an adhered marking layer atop the substrate.

56. A thermally activated chemically based marking method comprising steps of:

electrostatically applying a material containing at least one metal oxide comprising an energy absorbing enhancing component to a substrate to be marked in the form of a marking to be applied; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancing component, thereby forming a marking layer atop the substrate.

57. A thermally activated chemically based marking method comprising steps of:

electrostatically applying a layer of a marking material comprising at least one metal compound to a markable substrate comprising at least one material selected from the group consisting of metals, glasses, ceramics and plastics; and

irradiating said layer with a radiant energy beam having a wavelength selected to be absorbed by said marking material, thereby forming a bonded marking layer atop the substrate.

58. The method of claim 57, wherein said metal compound comprises a metal oxide.

59. The method of claim 58, wherein said metal compound is a mixed metal oxide.

60. The method of claim 57, wherein said metal compound is a sulfide.

61. The method of claim 57, wherein said metal compound is a sulfate.

62. The method of claim 57, wherein said metal compound is a carbonate.

63. The method of claim 57, wherein said marking material further comprises at least one energy absorbing enhancing component.

64. The method of claim 57, wherein said marking material comprises at least one colorant or pigment.

65. The method of claim 64, wherein said marking material comprises at least one organic pigment.

66. A thermally activated chemically based marking method comprising the steps of:

electrostatically applying a layer of glass frit material containing an energy absorbing enhancer to a glass substrate; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer in accordance with the form of a marking to be applied, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate; and

wherein the layer of glass frit material has a thickness ranging between 5 and 500 microns.

67. The method of claim 66, further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

68. The method of claim 66, wherein said glass frit material is applied as dry particles.

69. The method of claim 66, wherein said glass frit material is applied as liquid droplets.

70. The method of claim 66, wherein the glass frit material further comprises a borosilicate glass and the energy absorbing enhancer comprises carbon black.

71. The method of claim 66, wherein the radiant energy beam comprises a laser beam having an energy level ranging between 1 and 30 watts, a spot size ranging between 5 and 200 microns, and a marking speed along the substrate ranging between 25 and 1000mm/sec.

72. The method of claim 66, wherein said irradiating step is started at a room temperature of about 70 F.

73. The method of claim 66, wherein the glass frit material further comprises a colorant.

74. The method of claim 73, wherein said colorant comprises at least one organic pigment.

75. A glass material as marked by the process according to claim 66.

76. A thermally activated, chemically based marking method comprising the steps of:

electrostatically applying a layer of glass frit material containing an energy absorbing enhancer to a metal substrate; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer in accordance with the form of a marking to be applied, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate; and

wherein the layer of glass frit material has a thickness ranging between 5 and 500 microns.

77. The method of claim 76 further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

78. The method of claim 76, wherein the glass frit material comprises a borosilicate glass, and the energy absorbing enhancer comprises carbon black.

79. The method of claim 76, wherein the radiant energy beam comprises a laser having an energy level between 1 and 30 watts, a spot size ranging between 5 and 200 microns, and a marking speed along the substrate ranging between 25 and 1000mm/sec.

80. The method of claim 76 wherein said irradiating step is started at a room temperature of about 70° F.

81. The method of claim 76, wherein said grass frit material is applied as dry particles.

82. The method of claim 76, wherein said glass frit material is applied as liquid droplets.

83. The method of claim 76, wherein the glass frit material further comprises a colorant.

84. A metal substrate as marked by the process according to claim 76.

85. A thermally activated chemically based marking method comprising the steps of;

electrostatically applying a layer of glass frit material containing an energy absorbing enhancer to a substrate selected from the group consisting of glass, ceramic, porcelain, aluminum, brass, steel, stainless steel and tin; and

irradiating said layer with a beam having a wavelength selected to excite the energy absorbing enhancer in accordance with the form a marking to be applied, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate.

86. A thermally activated, chemically based marking method comprising the steps of:

electrostatically applying a layer of marking material comprising at least one of a mixed organic pigment material and an energy absorbing enhancer to a plastic substrate; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer in accordance with the form of a marking to be applied, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate.

87. The method of claim 86, further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

88. The method of claim 86, wherein said organic pigment material comprises carbon black.

89. The method of claim 86, wherein the energy absorbing enhancer comprises carbon black.

90. The method of claim 86, wherein the radiant energy beam comprises a laser beam having an energy level ranging between 1 and 30 watts, a spot size ranging between 5 and 200 microns, and a marking speed along the substrate ranging between 25 and 1000mm/sec.

91. The method of claim 86, wherein the layer of mixed organic pigment material has a thickness ranging between 5 and 500 microns,

92. The method of claim 86 wherein said irradiating step is started at a room temperature of about 70° F.

93. The method of claim 86, wherein said organic pigment material is applied as dry particles.

94. The method of claim 86, wherein said organic pigment material is applied as liquid droplets.

95. A plastic substrate material as marked by the process according to claim 86.

96. A thermally activated chemically based marking method comprising the steps of:

electrostatically applying a layer of glass frit material optionally containing an energy absorbing enhancer to a substrate to be marked in the form of a marking to be applied; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the glass frit material and/or said energy absorbing enhancer, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate.

97. A thermally activated chemically based marking method comprising the steps of:

electrostatically applying a layer of mixed metal oxide material containing an energy absorbing enhancer to a substrate to be marked in the form of a marking to be applied; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate.

98. A thermally activated chemically based marking method comprising the steps of:

electrostatically applying a layer of mixed organic pigment material containing an energy absorbing enhancer to a substrate to be marked in the form of a marking to be applied; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite the energy absorbing enhancer, thereby forming a bonded and permanent marking layer atop the substrate which is visible in contrast with the substrate.

99. The method of claim 98, further comprising the step of providing a laminar air flow across the substrate during the irradiating step.

100. The method of claim 98, wherein the radiant energy beam further comprises a laser beam having an energy level ranging between 1 and 30 watts and a marking speed along the substrate ranging between 25 and 1000mm/sec.

101. The method of claim 98, wherein said irradiating step is started at a room temperature of about 70° F.

102. The method of claim 98, wherein said organic pigment material is applied as dry particles.

103. The method of claim 98, wherein said organic pigment material is applied as liquid droplets.

104. The method of claim 98, wherein the layer of mixed organic pigment material has a thickness ranging between 5 and 500 microns.

105. A substrate as marked by the process according to claim 98.

106. A thermally activated, chemically based marking method comprising steps of:

electrostatically applying a layer of a marking material comprising a Kaolin clay to a substrate to be marked; and

irradiating said layer with a radiant energy beam having a wavelength selected to excite at least said Kaolin clay in accordance with the form of a marking to be applied, thereby forming a marking layer atop said substrate.

107. The method of claim 106, wherein said marking material further comprises an energy absorbing enhancer.

108. The method of claim 106, wherein said marking material is applied as dry particles.

109. The method of claim 106, wherein said marking material is applied as liquid droplets.